Assessing the Global Precipitation Measurement Level II and Level III with Multi-Radar/Multi-Sensor: current status and future directions

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Context

Characterization of satellite surface precipitation estimates and bridging Level-2 GPM core, constellation and combined Level-3 estimates. Needed in water cycle and extreme events studies, weather and climate prediction; over land in flood prediction and water resources.

Objectives

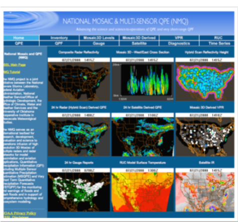
- use the NOAA/NSSL Multi-Radar/Multi-Sensor System (MRMS) system to provide a consistent reference research framework for creating conterminous US (CONUS)-wide comparison benchmark of precipitation retrievals across GPM core and constellation satellites.
- cross-platform characterization acts as a bridge to intercalibrate active and passive microwave measurements from the GPM core satellite to the constellation satellites, and propagate to Level-3 precipitation products.

Space sensors

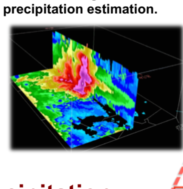
TRMM-PR/TMI, GPM-DPR/GMI, SSMIS, AMSR-2, DMSP-SSM/I, MHS, ATMS

Background: MRMS

MRMS provides 3D reflectivity mosaics and QPE products over CONUS at 1-km²/2-min resolution



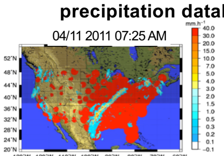
Real-time platform to develop, test, and assess advanced techniques in quality control, data integration and precipitation estimation.



http://nmq.ou.edu

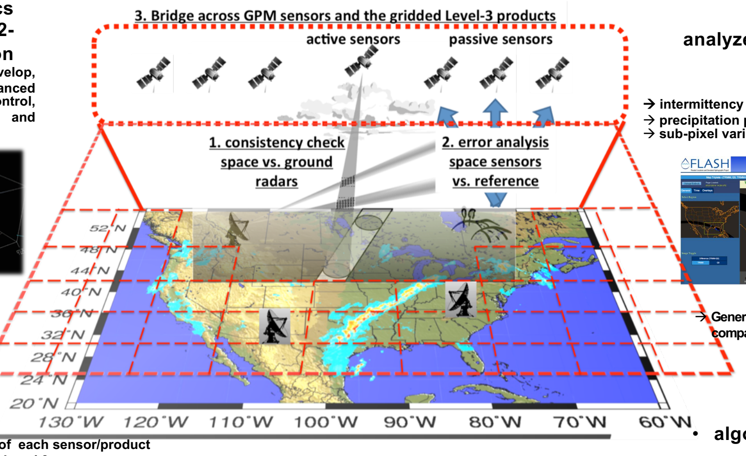
Reference precipitation

Establish a trustworthy reference precipitation database in real-time



products: 2A25 & 2A12
period: March-October 2011
sample: 500 000⁺

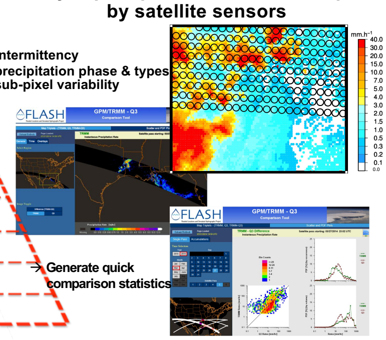
- → gauge adjustment
- → quality/quantity controls
- → precipitation types
- → matching the resolution of each sensor/product
- → active & passive Level 2, Level 3
- → used in GPROF at launch algorithm



Comparison

analyze precipitation features sampled by satellite sensors

- → intermittency
- → precipitation phase & types
- → sub-pixel variability



→ Generate quick comparison statistics

Disseminating data

- algorithm development & validation purposes (DPR & GMI)
- active/passive/combined level-2 and level-3 precipitation products

Brigding between sensors and products

→ between active and passive sensors, e.g. GPM-DPR vs. GPROF-GMI
→ between algorithms versions e.g. GPROF-GMI V04 vs. GPROF-GMI V05

Satellite L2
- orbital
- instantaneous

comparison

Reference L2
- 1km / 2min

scale impact

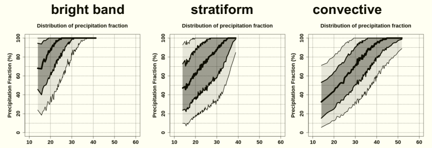
Satellite L3
- gridded
- 30-min

comparison

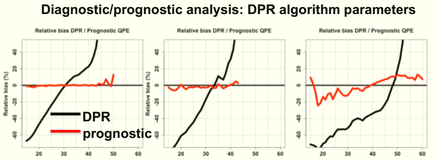
Reference L3
- 1km / 30min

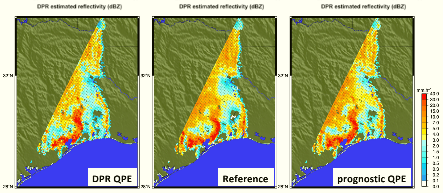
Active sensors: GPM Dual-frequency Precipitation Radar

Diagnostic analysis: intermittency within the DPR footprint



Diagnostic/prognostic analysis: DPR algorithm parameters





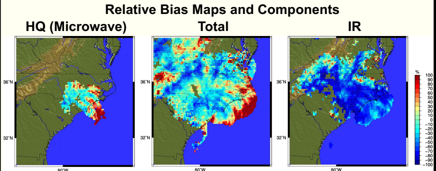
Storm system at 12:30 UTC on 18 April 2016 near Houston

Evaluation over the period June 2014 – Sept. 2016
(4M⁺ matched DPR-MRMS estimates)

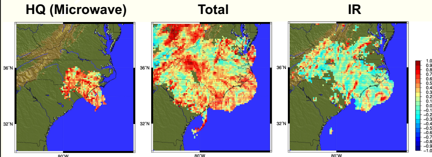
	brightband		stratiform		convective	
	Bias (%)	Correlation	Bias (%)	Correlation	Bias (%)	Correlation
DPR	+5.5 %	0.44	-19.5 %	0.36	-15.5 %	0.30
Prognostic	+0.05 %	0.60	-1.5 %	0.46	+3.5 %	0.53

IMERG - Hurricane Florence

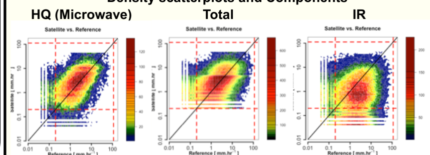
Relative Bias Maps and Components



Relative Bias Maps and Components



Density scatterplots and Components

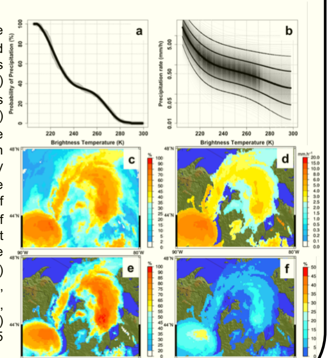


	HQ (Microwave)	Total	IR
Correlation :	0.4	0.37	0.17
Relative Bias:	+21.9%	-7.63%	-56.9%

Integrated Multi-satellitE Retrievals for GPM

Satellite-based quantitative precipitation estimation (QPE) requires more than just one deterministic "best estimate" to adequately cope with the intermittent, highly skewed precipitation distribution. A new approach called Probabilistic QPE using Infrared Satellite Observations (PIRSO) is proposed to advance the use of uncertainty as an integral part of QPE. PIRSO precipitation probability maps outperform conventional deterministic QPE by mitigating biases like PERSIANN-CCS used in IMERG. PIRSO quantifies uncertainty needed for precipitation ensembles and multisensor merging, and advances the monitoring of precipitation extremes for hydrometeorological hazards.

PIRSO precipitation rate distributions conditioned on the infrared brightness temperature with (a) proportion of positive rates (black curve), (b) distribution of positive precipitation rates. On subpanel (a) the grey curve represents the empirical proportion of positive rates. Example of precipitation system at 1200 UTC on 17 June 2014: PIRSO (c) probability of precipitation, (d) conditional expectation, (e) relative uncertainty, (f) probability of exceeding 5 mm.h-1.



Kirstetter, Karbalaee et al., submitted in QJRMS

Relevance and Broader Impact :

- development & evaluation GPM retrieval algorithms
- propagation of uncertainties in Level 3 precipitation

Any question or comment? Please contact me at:
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